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(54) IMPROVED VALVE-GATED INJECTION MOLDING MECHANISM

(71) I, JOBST ULRICH GELLERT, a Canadian citizen of 11 Newton Road, Brampton, Ontario, Canada, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an improved seal for a valve-gated injection molding mechanism. In a typical multi-cavity arrangement, a heater is enclosed in the mold above each cavity and molten plastics material is supplied from a centrally located molding machine through hot runner passages which extend through a manifold spreader plate and the heaters to the cavities. A valve pin is reciprocated vertically in a cylindrical bore in each heater by a rocker arm actuated by an air operated piston. A lower tip of each valve pin extends through a lower nozzle portion of the heater to provide a valve in a gate in the mold leading to each cavity. Closing of the valve thus provided is controlled by controlling the air pressure to the pistons. Prior art mechanism of this general type are disclosed in the applicant's Canadian Patent Nos. 840,892 issued May 5, 1970, 872,334 issued June 1, 1971, and 905,066 issued July 18, 1972.

The present invention disclosed herein in relation to one heater and cavity portion of a multi-cavity arrangement, may also apply to a single cavity arrangement. As is well known, heat transfer is of critical importance in mechanisms of this type. In order to reduce undesirable heat transfer, the manifold spreader plate and the heaters containing the hot runner passages are generally isolated as much as structurally possible from the rest of the mold by a surrounding air space. In the past, the portion of this air space accessible from the valve and gate area has naturally filled with pressurized molten plastics material from the hot runner passage or has been filled with a fitted machined insert of high-temperature plastics material such as glass fiber filled Teflon (Registered Trade Mark). Apart from heat transfer considerations, this has the disadvantage of introducing partially decom-

posed and discoloured plastics material into the cavity from time to time which results in colour streaking following color changes. While metal seals may be used to seal the air space against the flow of molten plastics material, this has the disadvantage that excessive heat is lost from the heaters across the metal seals to the cooled molds.

Accordingly, it is an object of the present invention to at least partially overcome these disadvantages by providing an improved seal to be located in the air space between the heater and the mold in a valve-gated injection molding mechanism.

To this end, in one of its aspects, the invention provides an injection molding valve-gated mechanism having a valve pin which reciprocates in a bore in a heater located in a mold to control flow of molten plastic from a molding machine through the bore to a cavity, the heater having a nozzle portion proximate the cavity which is separated from the surrounding mold by an air space which includes a region between the end of the nozzle and a gate to the cavity through which the valve pin projects to provide a valve in the gate to the cavity, and which includes a region extending circumferentially around the nozzle portion and flaring outwardly as it extends away from the cavity, the mechanism including a generally cylindrical seal surrounding the nozzle portion of the heater and located in the air space between the nozzle portion of the heater and the mold where the air space flares outwardly as it extends away from the cavity, the seal having an inner wall which abuts against the nozzle portion of the heater, an outer wall which extends away from the cavity from the mold across the outwardly flared air space to the nozzle portion of the heater, and an end surface between the inner and outer walls which surface faces the cavity and extends from the nozzle portion of the heater across the air space to the mold, the end surface having a V-shaped cross section formed by a first face extending diagonally outwardly from the inner wall and away from the cavity and a second face extending diagonally inwardly from the outer wall and away

from the cavity, the end surface forming an inner lip defined between the inner wall and the first diagonal face and an outer lip defined between the outer wall and the second diagonal face, only a portion of the outer lip abutting on the mold to reduce heat transfer through the seal from the nozzle portion of the heater to the mold.

The heater may be oriented with the valve pin vertical, in which case it is appropriate for the inner and outer walls of the seal to be vertical, the first face of the end surface of the seal extending diagonally outwardly upward from the inner wall and the second face extending diagonally inwardly upward from the outer wall.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a partial vertical sectional view of a multi-cavity arrangement showing the seal according to a preferred embodiment of the invention; and

Figure 2 is an enlargement of a portion of the sectional view seen in Figure 1, showing a portion of the seal seen in Figure 1 and a lower portion of the valve pin, the heater nozzle, and the surrounding portion of the mold.

Reference is first made to Figure 1 which shows a portion of a multi-cavity mold 10 positioned beneath a molding machine 12 with a first heater 14 enclosed in the mold above cavity 16. Upward from the parting line 18, the mold 10 includes a cavity plate 20, a support plate 22, a manifold spreader plate 24, an annular collar 26, a second heater 28, and a nozzle seat plate 29 located directly beneath the molding machine 12.

The first heater 14 has a circular electrical heater element 30, a lower nozzle portion 32 proximate the cavity 16 and a central vertical cylindrical bore 34. A vertical valve pin 36 having a larger upper portion 38 and a smaller lower portion 40 extends through the cylindrical bore 34.

In use, the valve pin 36 is reciprocated by a rocker arm 42 which pivots on a pivot pin 44 and is actuated by an air operated piston 46. Air pressure through air supply lines (not shown) drives piston 46 upward in a cylinder 48 located in a wall 50 in the annular collar 26 and the support plate 22. Molten plastics material is forced downward under pressure from the molding machine 12 through hot runner passage 52 which branches out through the manifold spreader plate 24 towards the different heaters and cavities. As may be seen in Figure 1, the hot runner passage 52 angles downward through the heater 14 where it joins the bore 34 of the heater at junction 54. The molten plastics material passes on downward through the bore 34 around the smaller lower portion 40 of the valve pin 36 where it passes through gate 56 into the cavity 16. As may be seen in Figure 2, a valve is provided by the frusto-conical lower tip 58 of valve pin 36 seating in the gate 56. The hot runner passage 52 enters the first heater 14 through collar 60 which projects slightly above the top surface of the heater 14 to provide sealing contact with the manifold spreader plate 24. The upper portion of the cylindrical bore 34 through the heater 14 extends through a bushing 62 which is centrally seated in the upper surface 63 of the heater 14.

Referring again to Figure 1, the hot portions of the mold 10 through which the hot runner passage 52 extends are separated from the cooler portions of the mold 10 so far as structurally possible by air spaces to reduce heat transfer between them. For instance, mold locating ring 64 which is in contact with the molding machine 12 is spaced from the second heater 28, which is also spaced from the annular collar 26. The hot manifold spreader plate 24 is spaced and located from the cooler support plate 22 by cylindrical spacer 66. While it is important to reduce heat loss at these points, heat transfer characteristics are even more critical in the lower nozzle portion 32 of the heater 12. Heat is provided by the electrical heater element 30 as well as by the melt from the molding machine and in order to reach the gate area, this heat must be transferred downward a considerable distance without being lost to the cooler surrounding mold. It is critical that sufficient heat reach the gate area in order to eliminate solidification of the melt in this area just prior to closing of the valve to allow lesser seating pressures to be used and thus extend the operating life of the mechanism. Thus the lower nozzle portion 32 of the heater is formed of a beryllium-copper alloy to promote downward heat transfer. The heater 14, while being securely positioned relative to the cavity plate 20 by insulation bushing 68, is spaced from the surrounding support plate 22 and cavity plate 20 by air space 70 which, as can be seen from Fig. 2 includes a region extending circumferentially around the nozzle portion 32 and a region between the end of the nozzle portion 32 and the gate 56 of the cavity. The valve pin 36 projects through this latter region. However, this arrangement has the disadvantage that the air space 70 fills with melt which then solidifies and reduces the insulative characteristics of the air space and as well results in colour streaking following colour changes. Thus it is desirable to provide a seal against the passage of melt through the air space to avoid the build-up of stale decomposing material, while at the same time not substantially increasing the amount of heat lost to the mold. The present inven-

tion provides a generally cylindrical seal 72 horizontally located in air space 70 between the lower nozzle portion 32 of the heater and the wall of the surrounding cavity plate 20. In the preferred embodiment the seal is formed of an alloy having over 90% titanium and lesser amounts of aluminum, vanadium and other elements. As may best be seen in Figure 2, the seal 72 has a vertical inner wall 120, a vertical outer wall 122 and a V-shaped lower end surface 124 between the inner and outer walls. The V-shaped lower surface 124 includes a first face 126 which extends diagonally upwardly (i.e. away from the cavity) and outwardly from the inner wall at an angle B of approximately 10 degrees to form a circumferential inner lip 128 and a second face 130 which extends diagonally upwardly and inwardly away from the outer wall at an angle A of approximately 30 degrees to form a circumferential outer lip 132. The lips terminate at a machined radius finish of approximately 10 microns to avoid breakage of the leading edges. The seal is located at an outward flare 134 in the air space 70 which is sufficiently far from the gate area that the reduced heat loss through the seal 72 is not taken directly from the gate area and yet sufficiently close that the molten plastics material which is injected into the remaining accessible air space 74 is sufficiently small that it is drawn out into the cavity 16 with each injection to avoid the streaking problem. The lipped structure of the lower end surface 124 of the seal 72 has been found to avoid the problem of pressure leakage past the seal which the applicant found made seals with a rectangular cross section ineffective. The upward pressure of the melt forces the lips against the lower nozzle portion 32 of the heater 14 and the cavity plate 20 respectively. The seal provided is of necessity a viscosity seal, i.e., it is not absolutely tight, but is effective to seal against the viscous plastics material. For instance, the seal may be formed to tolerances of .002 inches when cold and expand .0015 inches at operating temperatures. As may be seen, the vertical inner wall 120 substantially abuts on the lower nozzle portion 32 of the heater 14, but the reduced heat transfer characteristic of the seal is provided by the fact that in the upward direction, away from the cavity, the vertical outer wall 122 extends from the cavity plate 20 of the mold across the outward flare 134 of the air space 70 to the lower nozzle portion 32 of the heater with only a portion of the outer lip 132 abutting on the cavity plate 20 of the mold 10. The outer lip 132 is thicker than the inner lip 128 to allow minimized contact between the outer wall 122 and the cavity plate 20 while at the same time avoid the pressure of the melt breaking through the

outer lip 132 into the outward flare 134 of the air space 70.

It can be seen that the inner lip has smaller dimensions than the outer lip, both of height (in the direction away from the cavity) and of width (in the direction across the air space between the inner and outer walls).

Although the disclosure describes and illustrates a preferred embodiment of the invention, it is to be understood, that the invention is not restricted to this particular form of the mechanism. More particularly, it is apparent that the seal 72 may be formed of other material having suitable characteristics.

#### WHAT I CLAIM IS:—

1. An injection molding valve-gated mechanism having a valve pin which reciprocates in a bore in a heater located in a mold to control flow of molten plastic from a molding machine through the bore to a cavity, the heater having a nozzle portion proximate the cavity which is separated from the surrounding mold by an air space which includes a region between the end of the nozzle and a gate to the cavity through which the valve pin projects to provide a valve in the gate to the cavity, and which includes a region extending circumferentially around the nozzle portion and flaring outwardly as it extends away from the cavity, the mechanism including a generally cylindrical seal surrounding the nozzle portion of the heater and located in the air space between the nozzle portion of the heater and the mold where the air space flares outwardly as it extends away from the cavity, the seal having an inner wall which abuts against the nozzle portion of the heater, an outer wall which extends away from the cavity from the mold across the outwardly flared air space to the nozzle portion of the heater, and an end surface between the inner and outer walls which surface faces the cavity and extends from the nozzle portion of the heater across the air space to the mold, the end surface having a V-shaped cross section formed by a first face extending diagonally outwardly from the inner wall and away from the cavity and a second face extending diagonally inwardly from the outer wall and away from the cavity, the end surface forming an inner lip defined between the inner wall and the first diagonal face and an outer lip defined between the outer wall and the second diagonal face, only a portion of the outer lip abutting on the mold to reduce heat transfer through the seal from the nozzle portion of the heater to the mold.

2. The mechanism claimed in claim 1 wherein the inner lip has smaller dimensions than the outer lip, both in the direction away

from the cavity and in the direction across the air space between the inner and outer walls.

- 5 3. The mechanism claimed in claim 2 wherein the angle between the inner wall and the first diagonal face is approximately  $10^\circ$  and the angle between the outer wall and the second diagonal face is approximately  $30^\circ$ .

- 10 4. An injection molding valve-gated mechanism substantially as herein described

with reference to the accompanying drawings.

5. An injection molded article made utilising a mechanism according to any one 15 of the preceding claims.

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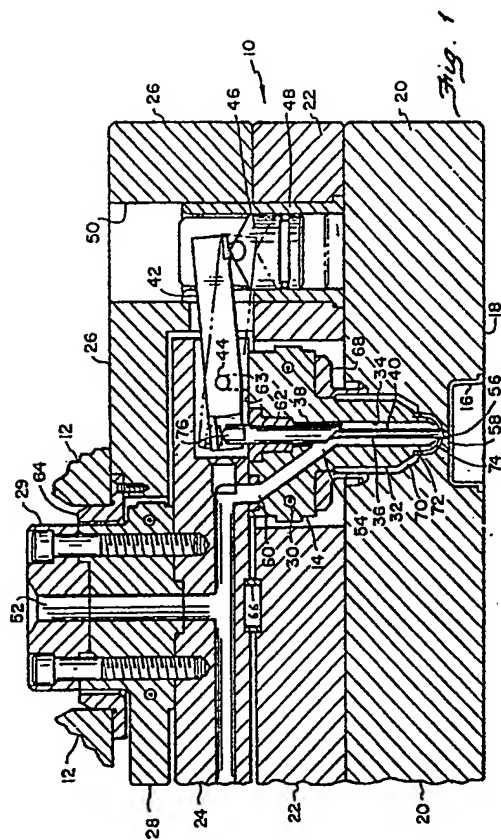
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Sheet 1



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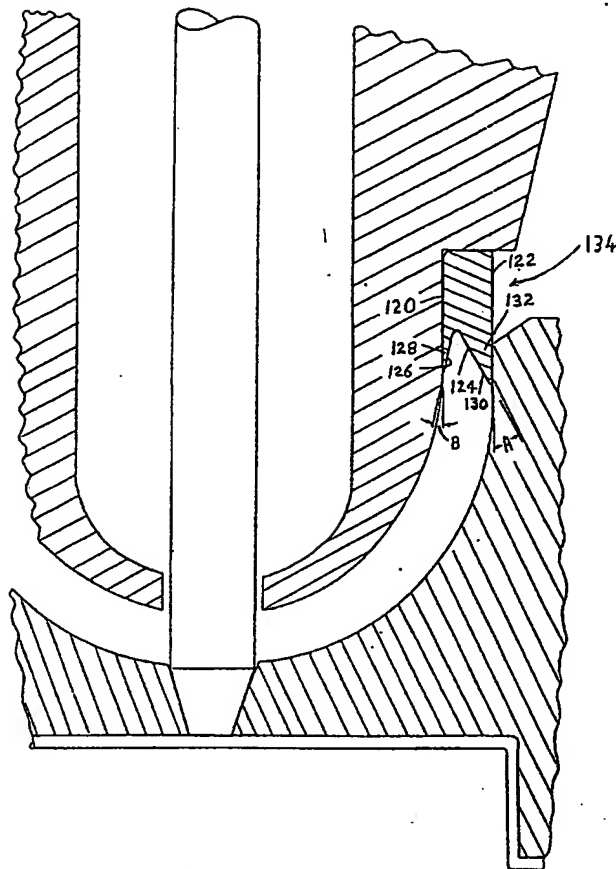


Fig. 2